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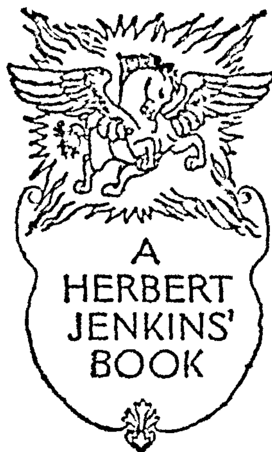
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IN THE GUNROOM

BY

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TO

E. P.

INTRODUCTION

IT has so happened that for the past ten years I have been responsible for the answers given to all questions dealing with Rifles, Shotguns and their Cartridges which have been addressed to the *Field*. In the course of time I found that certain questions seemed to be of more than passing interest to some individual, as they were constantly being asked at different times by different sportsmen It was this fact which suggested the idea of publishing a series of those questions which seemed to be of general interest, and this idea resulted in one hundred such questions and answers appearing in the pages of the *Field* under the heading of "In the Gunroom."

Quite a number of my friends have expressed their belief that the publication of this series in one single volume would prove of interest, and even help, to shooters in different parts of the world: and this is my only excuse for the appearance of this little book. But its publication could never have been possible without the permission of the Editor of the *Field*, to whom I would like to express my most real thanks for his great kindness in allowing me to reproduce what has already appeared in that paper.

On the whole the questions and answers are the same as those which were originally published, but one or two have been slightly altered to a form which seems more suitable for a book.

I offer this little volume to the shooting public with extreme diffidence and can only trust that it may prove of the same interest to that public as some of my friends have encouraged me to hope

G. BURRARD.

WILLOW LODGE, HUNGERFORD,
BERKS.
June, 1930.

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No. 1. The Sizes of Shotguns

Question.—*How are shotguns measured for size? Or, in other words, what exactly is the meaning of the terms, "Twelve-Bore," "Sixteen-Bore," etc.?*

Answer.—The method of indicating the size of a shotgun is very old and goes back to the time of muzzle-loading cannon. A cannon which fired a solid round shot of twelve pounds was described as a "Twelve Pounder," and so for other sizes. Similarly smooth bore muskets and guns were known by the weights of bullets which they fired. Such bullets were always made of lead and were spherical in shape. The weights of the bullets were sometimes given in ounces, but more often by the number of bullets which went to the pound. For example, a 2 oz. spherical bullet of solid lead was a No. 8, since eight such bullets made up a pound weight; a 1 oz spherical lead bullet was a No. 16, because sixteen such bullets weighed a pound; and so on Just as the cannon were known by the weights of their shot, so small arms became known by the weights of their bullets, and one which fired a No. 8 bullet was universally called a No 8 gun. This system of measuring calibres of both cannon and rifles was abandoned with the introduction of rifled breech-loaders which fired projectiles of far greater length than diameter, and both then became known by the actual diameter of the bore in inches, or fractions of an inch; *e g.*, 4-inch, 6-inch, 12-inch and 15-inch guns, and ·303, ·400, etc., rifles. It is a fact, however, that certain guns are still designated by the approximate weight of their projectiles, for instance, the 18-pounder and 13-pounder, but in these cases the appellation is no indication of the size of the bore.

In the case of shotguns, however, there was no fundamental change in the type of projectile used and so the old system of gauging has survived. It will, accordingly, be realised that a 12-bore is a gun of such a size that

twelve spherical bullets of solid lead, and of diameter the same as the diameter of the bore, would weigh exactly one pound. Similarly a 16-bore is a gun with a barrel of such a size that sixteen spherical balls of pure lead, each exactly fitting the bore, would go to a pound. It will be appreciated that the bigger the actual number denoting the gauge the smaller is the size of the bore.

No. 2. The Patterns of 12, 16 and 20 Bores at Different Ranges

Question.—*What are the comparative dispersions of 12, 16 and 20 bores at different ranges when the same degree of choke is used in each case? Or, in other words, what difference is there between the diameters of the total spread of the shot charge at different ranges in the case of 12, 16 and 20 bores?*

Answer.—The diameter of the total spread of the shot charge is, for all practical purposes, the same for 12, 16 and 20 bores when the same degree of choke is used in each case. For example, the diameter of the total spread of the charge from a full-choke 12, 16 or 20-bore is 30 inches at 33 yards, while the total spread of the charge from an improved cylinder 12, 16 or 20-bore has the same diameter at 23 yards. The dispersion is in fact the same irrespective of the size of the bore, and depends on the amount of choke.

No. 3. Improved Cylinders

Question.—*What exactly is meant by an "Improved Cylinder"?*

Answer.—An "Improved Cylinder" is really a very slight choke and is a constriction of from 3 to 5 thousandths of an inch in the diameter of the bore at the actual muzzle of the barrel Of course this constriction is not made in the form of a sudden step. It is a gradual taper or cone of $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in length. Some gunmakers enlarge or "recess" the bore immediately behind the rear end of the cone, and this recess may extend for 6 inches down the barrel with a maximum enlargement in diameter of 3-thousandths of an inch.

No. 4. Pattern Given by Full Choke

Question.—*If the choking of a gun is increased from 70 per cent patterns to, say, 80 per cent. patterns by means of the actual choke, and not by lowering the ballistics of the charge, does the velocity of the pellets suffer in consequence of the check given to the charge by the extra choke? When gunmakers have been asked, some decline to make a choke to give more than 70 per cent. patterns, while others say they will bore guns to give 80 per cent. patterns if desired. Can they do this with cartridges developing standard ballistics?*

Answer.—In the case of a 12-bore a full choke means a constriction near the muzzle of 40 thousandths of an inch. This is the maximum constriction which is used, and no full choke can be bored to give patterns regularly of much more than 70 per cent. provided the cartridges develop standard ballistics. If the ballistics are lowered it is possible to obtain patterns as dense as 80 per cent. In America many guns are bored very wide in the bore, with the result that the ballistics of the cartridges are lowered, and by this means very dense choke patterns are obtained. In England this system cannot be used on account of the Proof rules At the same time it should be remembered that a reduction in velocity need not result in any loss in penetration when large sizes of shot are used. This is because large shot retains its original velocity much better than small shot, and consequently at long sporting ranges the actual striking velocity of the large shot may easily be higher than that of the small, even though the muzzle velocity of the small shot was decidedly higher.

No. 5. Position of "Choke" in a Barrel

Question.—*Where exactly does the "choke" occur in a barrel?*

Answer.—"Choke" is a constriction in the bore of a gun varying from 5 to 40 thousandths of an inch in the case of a 12-bore. When less than 5-thousandths it is known as "improved cylinder." This constriction is made in the form of a taper or cone which varies in length from ¼ inch to ⅞ inch, the more the constriction the greater being the length of the cone. The distance of the head, or front end, of the cone may be anything between ¼ inch to 1¼ inches from the muzzle. Generally this distance is greater when the choke is greater, although gunmakers vary in their ideas as to the most suitable combination for the length of the cone of the choke and that of the parallel between the head of the cone and the muzzle.

No. 6. Possibility of Widening the Pattern of a Full Choke

Question.—*Is it possible to widen the pattern given by a full-choke gun by using cartridges in which the shot charges have been loaded in the cases in two or three sections with a thin card wad between each section of shot?*

Answer.—The pattern is certainly widened by this method of loading, but the results obtained are so irregular and uncertain that they cannot be depended on and so it is not to be recommended.

No. 7. Light-weight 12-Bores

Question.—*What is the lightest possible weight for a 12-bore shotgun fitted with 28-inch barrels?*

Answer.—The deciding factor is recoil, and if cartridges loaded with ordinary standard charges are to be used a gun lighter than 6 lb 4 oz. is not to be recommended, because the recoil developed by standard cartridges when fired in a gun lighter than this weight is too severe for the majority of shooters. It is possible to build a gun as light as 6 lb. which is perfectly safe, but the recoil would be excessive unless light shot cartridges were used

No. 8. Recoil Developed in Short-barrelled Guns

Question.—*In reply to question No 7 it was stated when ordinary standard cartridges are fired in a 12-bore gun which weighs less than 6 lb. 4 oz. the recoil is excessive. I was recently trying a 12-bore gun fitted with 25-inch barrels which weighed only 6 lb., and did not notice any severe recoil. What is the explanation?*

Answer.—Recoil is really the backward momentum of the gun, and this is exactly equal to the forward momenta of the shot charge, wads and powder gases These forward momenta are dependent on the total weight of the ejecta (*i e.*, the shot charge, wads and powder gases) and the velocity with which they leave the muzzle. If either the weights or the muzzle velocity is reduced, the forward momenta are reduced, which means the recoil is reduced. The cartridges usually loaded by gunmakers for use in these very light guns are loaded with light shot charges (1 oz.) while the velocities are also lower than standard. The reduction in the weight of the shot charge and the muzzle velocity results in a light recoil.

No. 9. The Best Length of Barrels for Shotguns

Question.—*What is the best length of barrels for shotguns? Is it true that very short barrels give more satisfactory results than formerly on account of improvements in modern powders?*

Answer.—There is no general best length of barrels. The best length of barrels for any individual is the length with which he finds he can shoot best. Some men find they can shoot better with short barrels while others can only shoot with long ones It is just as much a matter of personal individuality as the length of stock There is nothing new in short barrels, for 25-inch barrels have been in constant use for at least forty years, but the majority of shooters have seemed to prefer something longer. Barrels of 25 inches will prove just as killing as those of 30 inches, because the differences in the velocities developed are negligible at sporting ranges irrespective of what they may be at the muzzle.

The improvements in modern powders have nothing to do with the comparative efficiency of short and long barrels. This comparative efficiency is the same, for all practical purposes, as it was forty years ago.

No. 10. The Possibility of Shortening Shot-gun Barrels

Question.—*My gun has 30-inch barrels, the right improved-cylinder and the left half-choke. I want to try somewhat shorter barrels. If I have 2 inches cut off the present barrels, will it affect their shooting?*

Answer.—If 2 inches are cut off improved cylinder or choke barrels all the constriction at the muzzle in both cases will be removed, and consequently the shooting will be spoiled. It is possible, however, for a skilled gunmaker to separate the barrels for some distance at the muzzle end after a couple of inches have been removed, and then to swedge the ends of the shortened barrels down so as to make fresh constrictions. By this means it is possible to put choke into a true cylinder barrel, but the work is highly skilled and therefore expensive, while the results are not always certain. It is almost always better to buy a new pair of barrels than to shorten old ones.

No. 11. Weight of Trigger Pulls in Shotguns

Question.—*What are the normal weights for the trigger pulls in an ordinary double-barrelled 12-bore shotgun? Have gunmakers any standard if the pull-off is not specified when a new gun or guns are ordered?*

Answer.—There is no recognised standard pull, but generally the trigger of the right barrel has a pull of from 3½ lb. to 4 lb., and that of the left barrel one of from 4 lb. to 4½ lb.

No. 12. Relative Advantages of Side-lock and Box-lock Actions

Question.—*What are the real, as opposed to the fashionable, advantages of the side-lock hammerless ejector over other types? Is the side-lock gun essentially a better gun than the box-lock, and has not the latter type of action any advantages over the side-lock?*

Answer.—Weight for weight a side-lock action is stronger than a box-lock because the action is not cut away in the middle in order to make room for the locks. It is thus possible to build a light side-lock gun without any top extension such as is generally considered necessary for box-lock actions, even though in actual practice this top extension is not so serviceable as it is in theory.

It is also possible to obtain better and more regular trigger pulls with a side-lock, which is a very important point.

On the other hand, box-lock guns are slightly more weatherproof than side-locks; and they are simpler, and therefore cheaper, to build. Consequently a higher standard of workmanship is possible in a moderate priced box-lock gun than in a side-lock which costs the same, because there are not so many limbs to make in the box-lock.

No. 13. Comparative Quickness of Different Types of Locks

Question.—*What is the difference in the times which elapse between the pulling of the trigger and the striking of the cap in the case of a hammer gun, a hammerless side-lock gun and a hammerless box-lock gun, good quality locks being referred to in each case? Or, in other words, which is the quickest type of action?*

Answer.—The time which elapses between the pulling of the trigger and the striking of the cap depends on (1) the strength of the main spring, and (2) the angle through which the hammer falls. In all the types of lock mentioned in the query these two factors are practically identical. Consequently all are equally quick.

No. 14. Weights of Gun Stocks

Question.—*Is it true that the weight of a best quality gun stock does not depend entirely upon its length? I have recently acquired a second-hand highest grade gun by one of the leading makers which weighs 6 lb 9 oz, fitted with 29-inch barrels and a 13-inch stock I need a 15-inch stock, and had the existing stock lengthened. The gun now weighs 6 lb 12 oz. Could it be re-stocked with a 15-inch stock so as to weigh 6 lb. 9 oz ?*

Answer.—The weight of a best-grade gun stock does not depend entirely upon its length. Stocks are bored out to varying degrees and sometimes extra weight is added so as to obtain a perfect balance. But the wood which is used varies appreciably in density and weight It is quite possible to select two pieces of wood, both of which are perfectly seasoned, to make the same stock, but one of which weighs several ounces less than the other

It should be quite possible to re-stock the gun in question with a carefully selected 15-inch stock so as to retain perfect balance and keep the total weight of the gun down to 6 lb. 10 oz., if not 6 lb. 9 oz.

No. 15. Measurements of a Gun Stock

Question.—*Is it possible to send a gunmaker measurements from a gun which fits well so as to enable him to copy it without actually having the gun in his possession?*

Answer.—A gun made from measurements sent by post cannot be relied upon as an exact copy in every case, although such minor differences as may exist can usually be altered easily when the original gun comes to hand. There are three features of a stock which must be considered when sending a gunmaker measurements, namely, bend, length and cast.

Bend is measured by placing a long and perfectly straight rod on the rib of the barrels so as to protrude backwards over the stock. The two perpendicular distances from the comb and heel of the stock to this rod give the bend.

Length is obtained by measuring the distances of the heel, the centre and toe of the butt from the middle of the forward trigger.

Cast is very difficult for an amateur to measure correctly and the best course for the shooter to adopt is to give the gunmaker details as to his height, build and chest measurement. If an actual measurement is required the gun should be placed triggers upwards on a flat table in such a position that the centre of the rib coincides exactly with a straight line drawn on the table. Then the distance between this straight line and the foot of a perpendicular dropped to the table from the heel of the butt gives the cast

No. 16. The Effect of Shortened Barrels on the Fit of a Gun

Question.—*I had a favourite old gun which fitted me perfectly and with which I shot successfully for many years. As it was rather heavy I thought I would have a pair of 25-inch barrels fitted to it as well as the original 30-inch pair. This was done, but on trying the new barrels I found I missed birds which I felt sure I would have got with the old barrels, and so I went to a shooting school. There the instructor told me that I was shooting high with the short barrels, although I shot normally with the old ones. This cannot be due to the fit of the gun because the stock was the same in both cases. Is there any scientific explanation, or was it just an accident? It has occurred so consistently that an accident seems unlikely, but I can see no cause for the change.*

Answer.—The explanation is almost certainly to be found in the difference in the flip of the two pairs of barrels. Short barrels are stiffer and so they do not develop the same degree of downward flip as do long barrels, and it is probable that the 30-inch barrels in this particular case gave a bigger downward flip than usual. The result of this would be a tendency to shoot low, and this tendency was counteracted when the gun was originally built by the fit of the stock.

But when the new short barrels were fitted the downward throw produced by the flip was greatly reduced, and consequently the stock would need a greater degree of bend in order to give the shooter the same results as were obtained with the old barrels.

No. 17. The Fit of Over and Under Guns

Question.—*I have ordered a pair of Over and Under guns as I prefer the grip on this type of gun, and I sent one of my old guns (with ordinary horizontal barrels) which fits me perfectly, as a pattern for the stocks. But the gunmaker says that this is not sufficient and wants me to be refitted for the new guns because Over and Under guns need different fitting from ordinary guns. Is this a fact, and if so, why?*

Answer.—The barrels of an Over and Under gun are obviously far more rigid vertically than are those of a gun with barrels side by side. Consequently Over and Under guns develop considerably less downward flip than do guns of the ordinary type. On this account they show a marked tendency to shoot higher than ordinary guns, and to overcome this tendency the stocks usually require more bend, and so it is always better to be refitted in these circumstances.

No. 18. Chamberless Guns

Question.—*What is meant exactly by a "chamberless gun"? Also, is it true that this type of boring enables a shooter to use much heavier shot charges without a corresponding increase in recoil?*

Answer.—A "chamberless gun" is one in which the diameter of the bore is the same as that of the chamber. Thin brass cases only can be used in such guns, for if ordinary paper cases were used the wads would be too small to seal the bore during the passage of the shot charge down the barrel Owing to the absence of any form of chamber cone brass cases of different lengths can be used with equal efficiency, and consequently different loads can be fired effectively from the same barrel. The very fact, however, that thin brass cases only can be used must prevent such guns from ever coming into use for general shooting, but for wildfowling they are certainly excellent. They owe their development entirely to Dr. C J. Heath, the President of the Wildfowlers' Association, who deserves the greatest credit for his initiative in producing such a suitable and practical weapon

Very heavy shot charges of 2 oz. and over have been used in 12-bore chamberless guns which weigh as little as 8½ lb., without any severe recoil being noticed, and this absence of recoil has been explained by the fact that there are no chamber cones. This is incorrect. The true explanation is that these heavy shot charges are always used in conjunction with abnormally low powder charges with the result that the muzzle velocity of the shot charge is from 300 to 400 f.s. lower than that normally developed in an ordinary 12-bore There is, however, no loss in killing power because very large shot (BB) is invariably used This large shot retains its original velocity far better than small sizes owing to its greater ability to overcome air resistance, and possesses sufficient striking velocity, even

at extreme ranges, to kill cleanly. The disadvantage of large shot, namely, the open pattern, due to the small number of pellets in the charge, is overcome by the use of the abnormally heavy charges already mentioned.

Recoil is entirely a question of the momentum of the ejecta (shot, wads and powder gases) on their leaving the muzzle, which depends on their combined weights and velocity. A reduction in velocity enables the weight to be increased without any increase in recoil.

No. 19. Jammed Cartridges

Question.—*On returning from a very wet day on the moor I found, on reaching the lodge, that the cartridges were jammed so tightly that the primary extraction would not move them to any appreciable extent They had both been in the gun about half an hour. I fired them off, but this had no effect so far as the possibility of moving the cartridges was concerned, and I could not open the gun more than a fraction of an inch Consequently a hand extractor could not be used, and since it was not possible to open the breech the ejector springs were in action, so the fore-end could not be taken off or the barrels removed*

Finally I made an attempt to force the primary extraction with the result that one of the extractor heads broke, thus putting the gun out of action until a new extractor came from the makers.

What was the proper course to have adopted?

Answer.—After the gun had been fired the fore-end should have been removed and the barrels taken apart from the stock, when the fired cases could have been pushed out with a cleaning rod.

No harm can be done by taking a gun to pieces after firing and before opening it The ejector hammers do not fall until the gun is opened and the cartridge cases have been ejected, consequently the ejector springs are in a state of compression if the fore-end is removed from the closed gun whether the gun has been fired or not.

No. 20. Barrels Going Off Together

Question.—*It sometimes happens that I fire both barrels of my gun simultaneously without intending to do so. Does this damage or strain the gun, and what is the cause of my making the gun go off like this?*

Answer.—Both barrels of a gun cannot be fired absolutely simultaneously because the second is fired as the result of the firing of the first. Nevertheless the two barrels go off with such a short interval of time between them that they appear to be fired simultaneously. There is no doubt that this double explosion imposes an additional strain on the action; and if it were to occur frequently and the gun were not of best quality the barrels would probably be lifted slightly from the face of the action, even if more serious damage did not result

There is no single cause for the apparent simultaneous firing of both barrels, but the commonest causes are: (1) the trigger of the left barrel is too light, with the result that the lock of the left barrel is jarred off by the explosion of the firing of the right; (2) the trigger of the left barrel protrudes slightly to the right (in the case of a man firing from the right shoulder), with the result that it is caught by the trigger finger after the first barrel is fired; (3) the stock of the gun is too long for the shooter, with the result that the trigger finger is involuntarily slipped back on to the trigger of the left barrel

No. 21. Efficiency of Safety Catches

Question.—*When one slips the safety catch of a gun to the "Safe" position, is the gun really safe or can it be jarred off by a fall or knock? I have been told that the action of slipping the safety catch backwards and forwards actually uncocks and recocks the hammers. Is this so?*

Answer.—The safety catch on a hammerless gun is entirely independent of the hammers, and has nothing whatever to do with the cocking or uncocking of the locks The safety catch merely acts as a bolt on the triggers, and when it is in the "Safe" position it holds the triggers firm and prevents them from being operated in any way. But this does not mean that the gun is really safe, as it is quite possible for a gun to be jarred off by a fall or blow even when the triggers are locked by the safety catch, and this possibility is more pronounced in guns with very light trigger pulls. It is true that the intercepting safety sears should, theoretically, always prevent the hammers from falling unless the triggers are actually pulled. But unhappily this theoretical automatic safety device does not always work in actual practice, and there have been many instances of guns jarring off, even when the safety catches have been put to "Safe"

No. 22. Comparison between 12, 16 and 20 Bores

Question.—*Given that the dispersions of* 12, 16 *and* 20 *bores are the same at any given range when the guns are bored with the same degree of choke, as was stated in Question No.* 2, *then, provided the range be such as will give the necessary number of pellets in the killing circle, is one handicapped in any way by using the smaller bore? That is, provided one cuts one's range down in the case of the smaller bores, is there any greater difficulty in killing game within this range than with a larger bore? Or, to put the question in yet another way, is it more difficult to shoot with small bores, or is one's killing range merely curtailed?*

Answer.—Provided the different sizes of guns are all bored with the same degree of choke it is no more difficult to shoot with a small bore than a large. The only handicap is loss in killing range. The reason why small bores are generally rather more difficult to use effectively than larger bores is that gunmakers bore them more fully choked in order to overcome the loss in killing range.

No. 23. Relative Powers of 12 and 16 Bores

Question.—*Is it a fact or not that a light 12-bore shooting, say, 33 grains and 1 oz , will have greater velocity and striking energy (penetration) than a 16-bore regulated for 28 grains and $\frac{7}{8}$ oz. of shot?*

Answer.—For all practical purposes of sport the effective velocities developed by the 12 and 16 bores firing the loads specified above are the same, provided the same size of shot is used in both cases Consequently the penetration possessed at any given range by an individual pellet from either gun is the same The 12-bore has the advantage, however, because it throws a denser pattern owing to its heavier shot charge, provided both guns are bored with the same amount of choke If the 16-bore is more fully choked so as to give the same pattern as the 12-bore, shooting will be more difficult at close and medium ranges on account of the smaller spread of shot.

When both guns are bored with the same amount of choke a size larger shot may be used in the 12-bore without lowering the density of the pattern below that of the 16-bore. For example, No $5\frac{1}{2}$ can be used in the 12-bore and will give exactly the same pattern as No. 6 in the 16-bore because the shot charge is heavier. No. $5\frac{1}{2}$ retains its velocity slightly better than No. 6, and so at any given range the striking velocity of No. $5\frac{1}{2}$ will be somewhat greater than that of No. 6, which must give a slight advantage to the 12-bore in penetration, although this advantage would be almost negligible in actual practice.

No. 24. Comparative Powers of 12, 16 and 20 Bores

Question.—*What is the true comparison between the respective merits of 12, 16 and 20 bores? Is it true that the pattern, penetration and range of the 16 and 20 are equal to that of the 12, but owing to the smaller shot charge the killing circle is reduced in size? What is the actual difference in the killing circle of the three sizes? Assuming the all-round efficiency of the 12 to be 100 per cent, what figures would represent the others?*

Answer.—The only true method of making a comparison between 12, 16 and 20 bores, or between bores of any other sizes, is by comparing the actual weights of the shot charges fired by the different bores. For all practical purposes of sport the velocities are the same whatever size of gun is used, and consequently the effective range and killing power is dependent on the pattern. Provided the same size of shot is used in each case, the pattern depends on (1) the weight of the shot charge, and (2) the boring of the gun. The standard weights for the shot charges of 12, 16, and 20 bores are $1\frac{1}{16}$, $\frac{7}{8}$ and $\frac{3}{4}$ oz. of shot, and with these charges the actual patterns in 30-inch circles at 40 yards are the same in the case of an improved cylinder 12-bore, a half-choke 16-bore, and a full-choke 20-bore Consequently when guns of these sizes *and borings* are compared, the patterns, penetration and effective ranges are the same; but the smaller bores are more difficult to shoot with on account of the reduced killing circles due to the amount of choke used in each case At 25 yards the diameter of the effective spread of the whole charge is approximately 32 inches in the case of an improved cylinder, 26 inches for a half-choke, and 21 inches for a full-choke, *whatever size of bore is used.* At 40 yards the corresponding figures are approximately 46 inches, 40 inches, and 34 inches. When 12, 16, and 20 bores are all bored

with the same degree of choke, the larger bore is more effective, and if a 12-bore firing $1\frac{1}{16}$ oz. of shot is taken as 100 per cent., the equivalent percentages for 16 and 20 bores will be 82 and 70.

No. 25. "Hard Shooting" Powers of Different Guns

Question.—*I intend ordering a new gun and want to know if there is any truth in the belief that some makes of guns shoot harder than others?*

Answer.—The belief that some guns shoot "harder" than others is quite erroneous A bird is killed when a shot pellet penetrates some vital spot, and consequently killing power depends on the number of pellets which strike the bird, as the greater this number the greater the chances of hitting some vital organ, provided all these pellets strike the bird with sufficient velocity to ensure penetration.

The number of pellets which strike a bird at any given range is dependent on the boring of the gun, provided cartridges are being used which develop satisfactory ballistics. Consequently a full choke will always be more likely to kill a bird dead at moderately long ranges than an improved cylinder because it gives a denser pattern when other conditions are the same. But a full choke is not suitable for ordinary game shooting in Great Britain.

The striking velocity of the shot pellets is, for all practical purposes, dependent solely on the cartridge and has nothing to do with the gun. Consequently to speak of some individual gun as being a particularly "hard shooting" weapon is quite incorrect. The most important point in any gun is its power of giving evenly distributed and regular patterns when firing cartridges which develop standard ballistics.

No. 26. Strength of Striker Blow

Question.—*In reply to Question No. 25, it was stated that there is no truth in the belief that some guns shoot "harder" than others Does not the strength of the striker blow affect the velocity developed, and consequently the penetration ?*

Answer.—Provided that the striker blow is sufficiently strong to result in a proper detonation of the cap, and not cause hang fires, there is no proof that any extra strength of blow produces a more violent explosion. Consequently an increase in the force of the striker blow will have no result on the "hard shooting" powers of a gun

No. 27. The Effect of Oil in a Barrel on Pattern or Grouping

Question.—*Does a clean and slightly oiled shotgun barrel give a different pattern at 40 yards to what it would give after a cartridge has been fired through it? If so, why? Further, why does a shooter with money on himself go to the trouble of firing a cartridge before taking his stand at the live or clay pigeon?*

Answer.—Regularity of pattern in a shotgun really corresponds to close grouping in a rifle. Both shotguns and rifles are designed and made to give regularity of pattern or close grouping under conditions in which they will actually be used. These conditions entail a certain amount of fouling in the barrels Consequently it would be useless, even if it were possible, to try to regulate shotguns to give normal patterns from an oily barrel because the barrel would have to be cleaned out and re-oiled before every shot in order to reproduce similar conditions. An oily shotgun barrel gives a greater percentage of abnormal patterns than one which is fouled by a previous shot, just as a shot fired from an oily rifle barrel is frequently not found in the middle of a group made when the barrel is slightly fouled Generally speaking, oil in the barrel itself results in a more open and scattered pattern, but the exact reason for this is not known. Consequently the shooter who has money on himself will always do best to fire a cartridge through the barrel before taking his stand.

No. 28. The Effect of Oil in Chambers

Question.—*In Question No. 27 the effect of oil in a barrel on pattern or grouping was considered. No mention, however, was made of the effect of oil in the chambers of guns and rifles. Is it not a fact that an oily chamber results in dangerous pressures?*

Answer.—The effect of oil in the chamber of either a gun or a rifle has two aspects, namely: (1) the effect on ballistics; and (2) the effect on the powder pressure on the action. The effect on ballistics in the case of shotguns is nil. In the case of rifles the effect is not great, but it is certainly true that an oily chamber results in slightly higher velocities. It is reasonable, therefore, to suppose that these higher velocities are the result of higher chamber pressures. The exact cause of this increase in ballistics is not definitely known, although various theories have been formulated to explain it. But in any case the actual increase in pressure brought about by this aspect is not very great. The effect produced on the actions of rifles by the increase in powder pressure, however, is very decided. Experiments have been carried out with ·450–3¼-inch cordite cartridges which showed that when the chamber was very greasy the pressure on the action was approximately double that when the chamber was dry. Accordingly it will be seen that for degrees of greasiness of the chamber the pressure on the action will lie between the limits of a perfectly dry chamber and one which is very greasy. It is, accordingly, perfectly correct to state that an oily chamber in a rifle tends to dangerous pressures. In shotguns, however, the state of greasiness of the chambers has practically no effect on the force on the action.

No. 29. Bruised Second Finger

Question.—*I bought a second-hand gun recently which is satisfactory in every way except that the trigger guard bruises the second finger of my right hand. What is this due to, and is there any remedy?*

Answer.—In the great majority of cases a bruised second finger is an indication that the stock of the gun is too short, but other causes may be the comb of the butt being too far forward so that insufficient room is left for the hand on the small of the stock, the trigger guard being badly shaped, or abnormally loose holding of the gun on the part of the shooter. Apart from the lengthening of the stock, the simplest remedy is to remove the screw which holds the rear end of the trigger guard to the small of the stock and then slip an ordinary indiarubber umbrella ring over the end of the guard until it rests in the angle, when the guard can be screwed to the stock again. This type of rubber ring acts as an effective pad and prevents bruising

No. 30. Gun Headache

Question.—*What is the cause of gun headache, and what is the remedy?*

Answer.—The exact cause of gun headache is not understood and probably differs with individuals. Generally speaking, if the shooter is in normal health, it is the result either of severe recoil, or else of the combination of recoil and the jar of the explosion.

The usual remedy is a reduction of recoil by the use of lightly loaded cartridges, the shot being sometimes reduced to $\frac{15}{16}$ of an ounce and the powder to 30 grains of a 33-grain powder. Very light charges such as this, however, are not always effective against game, and consequently it is usually better first to try a combination of 33 grains of some 33-grain powder and 1 oz of shot Different kinds of powder can also be tried with advantage, and it is a fact that many sportsmen have been cured of gun headache by a change of powder. There is no definite rule, as powders affect individuals differently, but frequently the adoption of Empire powder has effected a cure, while we have known at least one case of a sportsman who could only use Ballistite with comfort. In the majority of cases, however, Empire seems to be the best powder for sufferers from gun headache, but sportsmen who do so suffer should experiment for themselves, first by reducing the shot charge to 1 oz, and then trying 33-grain loads of different kinds of 33-grain powders If headache still persists, the shot charge must be reduced to $\frac{15}{16}$ oz with a reduced load of whatever powder gives the least unpleasant results. In no case should 42-grain powders be used.

No. 31. "Snap" Shooting

Question.—*I have recently been told that the new way of shooting is by taking almost a "snap shot" at one's bird and that this is what is now taught at the shooting schools When I was at a London shooting school last year I was taught to bring my gun up on the tail of the bird and swing forward. Is there any advantage in this new method?*

Answer.—There is no "new" method of shooting. Some men swing quicker on to their birds than others. That is all, and the very quick swingers seem to "snap" their shots. It is true, however, that a very few men do really "snap" their shots and intercept their birds, but so few can do this successfully that this method is hardly ever advocated by an instructor.

No. 32. Forward Allowance

Question.—*I was recently told at a shooting school that the correct way to shoot is to keep your eye on the bird and swing the gun with the bird and press the trigger, and that it is wrong to make any forward allowance, i.e., to swing the gun to a position in front of the bird and to press the trigger when the gun is in that position I have asked one or two people who shoot rather extra well, and they say they always try to shoot in front of the bird, and that it is necessary to make a forward allowance My instructor said the velocity of the shot was so great that provided the gun was swinging on the bird, no forward allowance was necessary Which is correct?*

Answer.—A forward allowance is, of course, always necessary, and the shooting school instructor was entirely wrong in his explanation when he stated that the velocity of the shot was so great that it was only necessary to swing *on* the bird As a matter of actual fact, if a shooter swings " on " the bird and " blots it out with the muzzle of his gun," as shooting school instructors term it, it is not necessary to bother about forward allowance for all shots at moderate ranges, because the very fact that the bird is " blotted out " means that the gun must be pointing ahead of the bird, which gives a forward allowance. If the trigger is then pressed without any check in the swing a kill will probably result.

At long ranges, however, a more decided forward allowance is required and then the shooter will have to swing well through and past the bird and press the trigger without any check in his swing

No. 33. Forward Allowance at Long Range

Question.—*To estimate correctly the necessary forward allowance when shooting at ranges of from 20 to 40 or 50 yards must be almost impossible Is it not a fact that at long ranges one points the gun at what looks like a gun's length ahead of the bird and swings forward? Or should one try to throw one's gun 12 feet or more ahead of the bird in the first instance?*

Answer.—It is impossible to give any definite rule, as a method which may help one man may only confuse another. Probably the method which is most generally recommended is to bring the gun up behind the bird, and then swing right through in the direction in which the bird is flying, and finally to pull the trigger without any check in the swing when the gun is pointing well ahead of the bird.

It is impossible to judge any particular number of feet as a forward allowance; but it is useful to know what the approximate forward allowance is at various ranges, as the possession of such knowledge may impress upon one the necessity for swinging well ahead of the bird at long range It is doubtful whether any shooter can tell to a yard, let alone to a foot, what forward allowance he gives. He is merely conscious of swinging well through.

No. 34. Effect of Using Different Shotgun Powders

Question.—*Shooters are advised always to stick to one brand of powder. Is this because different powders require different forward allowances on crossing birds ? For example, if a shooter fired at a bird with a cartridge loaded with E C. in the belief that it was loaded with Smokeless' Diamond (which he always uses), would the position of the bird in the shot pattern be the same as if Smokeless Diamond had been used ?*

Answer.—It is always better to use the same brand of powder and the same charge, both of powder and shot, as those for which the gun was originally regulated by the gunmaker, as such will generally give the most regular patterns In actual practice, however, there is little difference in the results obtained with different powders, and there is no difference in the velocities developed provided the shot charges are the same in each case Consequently the necessary forward allowance on a crossing bird is identical when using Smokeless Diamond, E C , or any other reliable brand of powder in cartridges which have been properly loaded, and the position of the bird in the pattern is not affected by the kind of powder used

The strongest reason for sticking to one kind of powder is a psychological one, as a sportsman will always shoot better when using cartridges in which he has confidence based on long usage, than he will when trying new loads or charges In the latter case a few misses may lead to doubt in the cartridges and doubt is fatal to good shooting.

No. 35. Bulk Powders

Question.—*What exactly is a "bulk" powder?*

Answer.—The term "bulk" was applied to shotgun powders when black powder was replaced by smokeless powders. The standard charge for a 12-bore 2½-inch case was 3 drachms of black powder, but for convenience in loading hoppers, or measures, were invariably used, each of which contained a volume of powder which weighed exactly 3 drachms. Smokeless powders were found to be much lighter in density than black powder, yet for purposes of general convenience in loading they were so standardised in manufacture that the same measure could be used for them as for black powder. In other words, the charge of smokeless powder was the same as that of black powder when measured by *volume*, or *bulk*, but not when measured by weight. The term "bulk" then became applied to all smokeless powders which could be loaded correctly with a black powder measure, and it has been in general use ever since. Schultze, Amberite, E C., Empire, and Smokeless Diamond are all "bulk" powders, as volume for volume they give similar ballistics to the best grades of black powder.

No. 36. Classification of Shotgun Powders

Question.—*What is meant by the expressions "33-grain" and "42-grain" powders?*

Answer.—A 33-grain powder is a powder of which the amount required to fill a 3-drachm black powder measure weighs exactly 33 grains, and a 42-grain powder one of which the same amount weighs 42 grains.

No. 37. Fibrous Shotgun Powders

Question.—*What is meant by a Fibrous Powder?*

Answer.—A powder is called fibrous when it is made from nitro-cellulose, and has a fibrous appearance when examined by a pocket lens Actually fibrous powders, for example Schultze, are made by rolling a mixture containing finely divided nitro-cellulose up into grains. In order to prevent these roundish grains from breaking up on handling they are what is called hardened; that is, they are treated with solvents which make the nitro-cellulose fibres cohere, more or less, without destroying the fibrous appearance. The fibrous hardened grains can be broken down by rubbing in the palm of the hand.

Functionally a fibrous powder grain is easily penetrated by the hot powder gases which arise during burning, and so the grains are easily burnt up, because the thickness of powder to be burned is of the order of the diameter of a single nitro-cellulose fibre.

No. 38. Gelatinised Shotgun Powders

Question.—*What is meant by a Gelatinised Powder?*

Answer.—A gelatinised powder is one which has been made by forming a dough into grains The dough is made by treating a nitro-cellulose mixture with solvents in a mixing machine This resulting dough-like mixture is submitted to pressure in presses, or rolling machines, and the grains are formed from the cords, tubes and sheets thus produced. In this way solid grains are formed which are not penetrable by the hot powder gases formed during burning, and, therefore, the powder grains only burn on the surface. Consequently the grains have to be very thin to burn up in a shotgun. Powders of this kind are Coopal No. 2, T Powder and Mullerite, and they are called solid grain powders. To avoid the necessity of making very thin grains for shotgun powders, some gelatinised powders are made porous by adding to the nitro-cellulose mixture, which is formed into a dough, a substance which is subsequently removed and so leaves pores in the grains. Such are called porous grain gelatinised powders, and an example is Smokeless Diamond

A gelatinised powder has no fibrous appearance when examined by a pocket lens. Even in a porous powder the pores are not readily seen by a lens because they are so small, but they are large enough for hot powder gases to enter under the pressure which is generated in a gun barrel, and, therefore, the grains are readily consumed.

No. 39. "Progressive" Powders

Question.—*What is meant by a "Progressive" Powder?*

Answer.—A "progressive powder" is one which develops gases more rapidly as burning proceeds, when this burning takes place at a constant gas pressure. These powders are of two classes, namely: (1) Gelatinised powders consisting of multiperforated grains, in which the burning surfaces increase as combustion proceeds These powders are used in ordnance. (2) Powders consisting of grains made up of layers which vary in rate of combustion, the outer layer being slow in combustion and the inner layers or core quick in combustion. These powders are used in small-arms.

The word "progressive," as applied to class (2), was coined by Nobel in his patent of 1896, when he said: "The progressive quality is obtained by introducing chemical substances in the outer layers of the compound capable of modifying its explosive character."

The idea is that the projectile should be started in its movement by the slow explosive on the surface of the grains, and the initial pressures are thus kept low; further movement is continued by the more violent explosive of the core of the grains, and a more sustained barrel pressure is thus created.

For small-arms powders the progressive character is given by coating the grains with moderating substances which are allowed to penetrate to varying degrees below the surface of the grains; the grains are surface moderated. Because a progressive powder is one which gives comparatively low initial pressures and sustained barrel pressures, powders which have these characteristics are said to be progressive even when the grains are not surface moderated.

No. 40. Progressive Shotgun Powders

Question.—*Which shotgun powders, if any, burn progressively?*

Answer.—It depends what is meant by "burning progressively." In comparison with shotgun powders used many years ago, all powders made at the present time are more or less progressive in that they develop better sustained barrel pressures.

But if the expression "burning progressively" refers to powders in which the outer layers of the grains are less explosive than the cores, it is safe to state that only two shotgun powders of this type are made, both of these being American.

To obtain this type of progressive action by coating the surfaces of the grains or some similar method of obtaining surface moderation of action, the powder must be a gelatinised type with solid grains Such powders are not so easy to ignite as fibrous powders

The combustion of fibrous powders, or those with porous gelatinised grains, which are surface moderated, does not begin by the burning of the outer layers of the grains, because the hot powder gases can penetrate the grains and cause them to burn just as readily and as quickly at the cores as at the surfaces. Consequently it is clear that surface moderating cannot give a more progressive fibrous or porous grain powder, as is sometimes claimed, by starting the burning with a slow outer layer of explosive and finishing with a quicker one at the core If surface moderating ever results in a really more progressive fibrous or porous grain powder, this result is only achieved by some other principle considerably more abstruse.

No. 41. Recoil given by Different Powders

Question.—*Why do Schultze and Amberite powders always give a heavier recoil than Smokeless Diamond when the same shot charge is used?*

Answer.—Recoil is dependent solely on two things: (1) the total combined weights of all the ejecta (that is, the combined weights of the shot charge, wadding and powder gases), and (2) the velocity with which these ejecta leave the muzzle Schultze and Amberite are what are known as 42-grain powders; that is, 42 grains by weight of either of these powders will exactly fill a 3-drachm black powder measure. Smokeless Diamond, E C. and Empire are all 33-grain powders; that is, 33 grains by weight of any of these powders will exactly fill a 3-drachm black powder measure Consequently the *weight* of the powder charge in the case of Schultze or Amberite is heavier than in the case of Smokeless Diamond, E.C or Empire, although the *bulk* is the same in every case (assuming that standard charges are used in all cases). On the assumption that the whole of the powder charge turns to gas on combustion—as it should—it will be obvious that the weight of gas evolved by a charge of either Schultze or Amberite is greater than the weight evolved by Smokeless Diamond, E C. or Empire Consequently the total weight of the ejecta is greater in the case of the first two powders than in the case of the last three; this is why the recoil is heavier.

No. 42. "Quickness" of Different Shotgun Powders

Question.—*Certain powders are advertised as being "quicker on the bird" than others. Is there anything in this claim?*

Answer.—No. The "quickness on the bird" developed by any cartridge is really entirely dependent on the time of flight of the shot charge from the muzzle to the bird, and this in its turn depends on the muzzle velocity of the shot charge and the capacity possessed by the shot pellets for retaining that velocity, or in other words, the *average* velocity over the range. In actual practice all cartridges are so loaded that the average velocity over the range is the same, irrespective of what powder is used. It is true that this average velocity may be increased very slightly by imparting an extra high muzzle velocity. But this can only be done by a combination of a light shot charge and a heavier powder charge: the type of powder used is immaterial.

No. 43. Importance of Good Wadding

Question.—*One reason given for the considerable difference in price between two brands of ordinary shotgun cartridges was the difference in quality of the felt wadding used in the two brands. Is this explanation correct; and if so, does the better quality felt make sufficient practical difference in the actual shooting field to be worth the extra cost?*

Answer.—Felt varies greatly in quality and price, the inferior qualities being considerably cheaper. Consequently it is quite correct to state that different qualities of felt wads make one of the contributory causes to the difference in price between brands of cartridges.

The felt wad is one of the most important components of a shotgun cartridge, and its function is to expand under the impact of the explosion and seal completely the bore behind the shot charge, thus preventing any of the powder gases escaping through the shot charge. Not only does the felt wad play an important part in the actual development of the ballistics of the cartridge, but it also has a considerable effect on the pattern of the shot charge. Generally speaking, the better the quality of felt wad used the better the pattern. It is, consequently, well worth while to get cartridges loaded with good quality felt wads.

No. 44. Constant Volume Loading

Question.—*What is meant by "Constant Volume Loading," and is this system of loading an advantage?*

Answer.—Constant volume loading is adopted by some Continental manufacturers of shotgun cartridges The powder chamber of the cartridge case is fitted with a lining, the diameter of which is slightly smaller than the diameter of the rest of the case. The effect of this is that a step is made at the top of the powder chamber. A card wad is placed on this step which cannot be pressed further down on the powder, with the result that the volume given to the powder space is always constant, and compression of the powder is impossible In theory this system is excellent, but in actual practice it has not proved very satisfactory. The reason is that any variation in the weight of the powder charge has effects on the ballistics in two ways. First, on account of the actual variations of the density of loading owing to the reduced air space left in the powder chamber; and secondly the variation produced by the different weight of powder. The existence of this double source of variation in ballistics has been found to result in greater variations than are produced by the original system of loading, in which the wads are rammed on top of the powder. On the whole, constant volume loading has not been found suitable for British powders, and is not recommended. There is even a danger in constant volume loading as adopted in some instances The supporting lining in the case may be very thin, and then there is the risk of the wadding being forced within it, thus reducing the air space and materially increasing the pressure.

No. 45. Gastight Cases

Question.—*Is there any real advantage in having an iron lining to shotgun cartridges, such as is used in "gas-tight" cases?*

Answer.—An iron lining produces a stronger case, and consequently results in slightly higher and more regular ballistics. If cartridges are to be kept a long time, "gas-tight" cases are preferable, but for ordinary work they cannot be regarded as adding very materially to the efficiency of the cartridge.

No. 46. Storage of Cartridges

Question.—*Is there any truth in the theory that cartridges deteriorate when kept from one season to the next, even if carefully stored, and what are the best conditions under which they should be kept?*

Answer.—Under favourable conditions shotgun cartridges will keep in good condition for years Shotgun powders are chemically very stable under all sorts of climatic conditions on account of their porous nature and the ease with which the gaseous products of decomposition escape from the powder grains The variation in the ballistics of shotgun cartridges under extreme climatic conditions depends on (1) the temporary effect produced on the powder, *i e.*, the moisture contents and variation in rate of combustion due to temperature, and (2) the effects, both temporary and permanent, produced on the paper case A case drier than normal is smaller in diameter than normal and the turnover offers more resistance, which increases ballistics When a paper case is allowed to become alternately damp and dry, the shot charge gets loose owing to the turnover unrolling slightly, and this lowers the ballistics. It will accordingly be realised that if there were no variations in temperature or humidity of the atmosphere the ballistics of cartridges would remain constant for an indefinite period Such conditions are, however, impossible to realise, but they represent an ideal which indicates the best practical conditions for storing cartridges. A library is usually a very good place as conditions favourable to the preservation of papers and books are the best possible for cartridges. Extremes of dampness or dryness, or heat or cold, should be avoided as much as possible, and when this is done there is no reason why cartridges should not keep perfectly for many seasons

No. 47. Large Continental Caps

Question.—*Do the large-sized caps used in some makes of Continental shotgun cartridges effect any improvement in ballistics when used in conjunction with British powders?*

Answer.—One very common Continental cap is actually slightly smaller than the standard British cap although it looks larger owing to its outer covering, but there are two kinds of Continental caps which really are larger. In one of these the anvil is made in the cap chamber by raising its base, and in the other a legged anvil is used, the leg of which protrudes through the flash hole These methods of manufacture necessitate the use of a large cap and cap chamber, and so the manufacturers are compelled to use a large charge of cap composition. This necessitates a comparatively weak and low temperature flame composition being used, so as not to disturb the pressure level of cartridges loaded with ordinary powders. As is often the case, when manufacturers are compelled to deviate from general practice, merit is made of necessity. Tests have proved that these large caps have produced no improvement in ballistics, while the opposite effect has frequently been recorded. The reason for this is that although the amount of cap composition may be larger the flame produced by this composition is weaker and of a lower temperature than that given by British caps.

No. 48. Shotgun Cartridges in Extreme Cold

Question.—*During cold winters in East Prussia, when there are 15 to 18 degrees Centigrade of frost, we find it almost impossible to shoot on account of the failure of the cartridges to explode properly I have used German Rottweil and the American Ballistite, and both give the same poor results. There is no effect up to 2 or 3 degrees of frost, but anything over 8 seems to do the trick The Germans, when forced to use these cartridges under such conditions, keep their cartridges in a pocket close to the body until the last minute before expecting to use them For wild duck shooting from open ditches this is, of course, a hopeless business, as one never knows when a shot may be expected My experience certainly confirms that of the local sportsmen While out shooting with a German party a few weeks ago I noticed a very peculiar effect One of the guns (a good shot) fired at a running hare at about 35 yards, the position of the line of shot being between myself and the setting sun. On the shot being fired, instead of the usual clean discharge from the end of the barrel, a sort of discoloured mist travelled* along *the ground from about 15 yards in front of the shooter, but out of all perspective to the angle of aim. Of course, the hare went away uninjured, but the shooter never failed to complain that he could not understand what had happened I looked at his cartridges and they were of the best standard variety. I came to the conclusion that in this case the powder had not completely exploded, and that the powder and the shot together had sort of dribbled out of the gun, giving the effect that the shooter had aimed so badly at a hare 35 yards away, that he had hit the ground 15 yards in front of him, and the shots had ricochetted along the ground. This was a case where the cartridges had been carried in the gun for a matter of two hours, and had become thoroughly cold.*

Answer.—The difficulties experienced in very cold weather are almost invariably due to the fact that gelatin-

ised powders are used instead of fibrous powders. Both Rottweil and Ballistite are gelatinised powders, and in common with other powders of this type they suffer from being difficult to ignite.

In very cold weather the oil in the locks is partially frozen, and this semi-frozen oil clogs the locks and prevents the hammers from falling with their full force, thus reducing the strength of the striker blow. Further, the metal of the walls of the chamber and the face of the action, as well as the metal of the cap chamber and the cap anvil, are all intensely cold. This tends to reduce the temperature of the cap flame. The resulting enfeebled flame fails to ignite gelatinised powders, and the incident noted is clearly a case of a "fizzle" due to incomplete combustion of the powder, which is the result of faulty ignition

The remedy is to use a fibrous type of shotgun powder, such as Schultze or E C., both of which were used regularly with excellent results before the war by British sportsmen shooting in Russia during the winters

No. 49. The Best Shotgun Powder for Hot Climates

Question.—*Is it a fact that in hot climates those shotgun powders which contain nitro-glycerine, such as Ballistite, do not give such good results as those which contain inorganic nitrates in addition to nitro-cellulose, such as Schultze and Amberite? If so, what is the reason?*

Answer.—The combustion of powders which contain nitro-glycerine, whether shotgun or rifle powders, is more affected by high temperatures than that of powders which do not contain this ingredient. This is known from experience. In hot climates the violence of powders which contain nitro-glycerine is certainly above the normal; and it is also true that powders such as Schultze and Amberite, which both contain exceptional amounts of metallic nitrates, are generally preferable for use in the tropics. Possibly the explanation for the more even results given by these last-named powders in hot climates rests on the fact that they contain lower percentages of nitro-cellulose than similar non-nitro-glycerine powders because of the higher percentage present of metallic nitrates; and it is this lower content of nitro-cellulose which gives them an advantage in the tropics.

No. 50. Reloading Shotgun Cartridges

Question.—*What implements exactly are necessary for the loading and reloading of shotgun cartridges, and how is the loading or reloading performed?*

Answer.—For the loading of shotgun cartridges the following implements are required: Powder measure, shot measure, wooden rammer, and turn-over machine. For reloading old cases the same implements are required with the addition of a re-capping machine

To load new cases, first measure the correct quantity of powder with the powder measure, the accuracy of which should have been tested by weighing a few charges it throws, then place a $\frac{1}{12}$-inch card wad in the case over the powder, taking great care to keep this wad as level as possible. Then ram the thick felt wad down on top of the card wad by means of the wooden rammer, and then insert another card wad, which should also be pressed home to the mark on the rammer, this mark having been previously fixed so that a correct length of case is left for turning over. The shot charge is next inserted and a card wad placed over the shot. The cartridge is then placed in the turn-over machine, and the turn-over is made, which completes the process.

For normal charges of powder and $1\frac{1}{16}$-oz. shot the felt wad should be $\frac{7}{16}$ inch in thickness and the over shot card wad $\frac{1}{16}$ inch.

Schultze powder is recommended for home loading as it gives more regular results in varying conditions of hand-loading, and is generally more "fool-proof."

When reloading fired cases it is first necessary to remove the cap by the re-capping tool, then a new cap is inserted with the same tool. Then insert the wooden rammer, which should almost exactly fit the inside of the case, inside the fired case and roll the fired case backwards and forwards between two boards with the brass rim outside

of the boards. This is in order to render the tube round and suitable for insertion of wads and compact for turning over again. *Afterwards proceed as in loading new* cases.

No. 51. Nitro-Proof Charge for Shotguns

Question.—*What is the current nitro-proof charge for an ordinary 12-bore shotgun, and what is the pressure developed?*

Answer.—The current nitro-proof charge for a $2\frac{1}{2}$-inch 12-bore was introduced in 1925 and is now called the definitive proof charge. It is compulsory for all guns, and consists of 178 grains of T.S.P. and $1\frac{1}{16}$ ounces of shot. With the table of pressures now in use it is probable that this definite proof charge develops a pressure of about five tons. The British proof authorities do not publish proof pressures, and the special proof powder, T.S P., is a private powder and is not, therefore, available for testing.

No. 52. The Effect of Wind on Shot Pellets

Question.—*Does wind have any practical effect on a shot charge? Is it true that when one shoots directly into a strong wind the velocity of the shot pellets is reduced?*

Answer.—For all practical purposes of sport wind has no effect on shot pellets. It is true that a strong wind blowing across the line of fire must give the pellets a slight deflection. But this deflection rarely amounts to as much as 10 per cent. of the total forward allowance required on a crossing bird, even in the case of a strong wind. The effect of a contrary wind on the striking velocity is even less. When shooting into the teeth of a strong wind the velocity of No 6 shot would be the same at 39 yards as it would normally be at 40 yards in still air.

No. 53. The Effect of Wind on Different Sizes of Shot

Question.—*Does wind have any different effect on shot charges of different sized pellets? That is, would a charge of No. 4 be affected less than one of No. 7?*

Answer.—For all practical purposes of sport wind has no effect on shot pellets, no matter what their size. It is true that a strong wind blowing across the line of fire must give the pellets a slight deflection, and that this deflection will be greater in the case of small shot, such as No. 7, than with large, such as No. 4. But in any case the deflection is so slight that it would make no practical difference in shooting

No. 54. Penetrative Powers of Large and Small Shot

Question.—*Many years ago an old keeper told me, "Use small sized shot; it gets through the feathers more easily" Is this true? The diameter of a No. 4 pellet, for example, is of course greater than that of a No. 6. Accordingly it has greater resistance (other things being equal) to overcome in penetrating either fur or feather. Does the extra weight of the No. 4 pellet counterbalance that apparent disadvantage?*

Answer.—Given equal striking velocities the power of penetration possessed by large shot is greater than that of small, and the belief that small shot "gets through the feathers more easily" is quite erroneous It is true that owing to its larger diameter (and therefore to the larger superficial area which meets with resistance) a pellet of No. 4 has greater resistance to overcome than one of No 6 when both are travelling at the same speed. But the heavier a shot pellet is the more easily it is able to overcome any resistance to its movements, and the extra weight of a No. 4 pellet more than counterbalances the disadvantage of its larger area.

In more technical parlance, the power of any individual shot pellet to overcome resistance to motion varies *inversely* as the *square* of its diameter, but *directly* as the *cube* of its diameter. Therefore the net result is that the power to overcome resistance actually varies as the diameter of the pellet.

For example, the diameter of a pellet of AAA is almost exactly double that of one of No. 6, so a pellet of AAA will be able to penetrate twice as easily as one of No. 6.

The power of penetration possessed by an individual pellet is really the same as its capacity for overcoming air resistance, and it is general knowledge that large shot retains its velocity (that is, overcomes air resistance) better than small.

No. 55. Spread of the Shot Charge

Question.—*What is the diameter of the spread of the whole shot charge at 40 yards in the case of improved-cylinder, half-choke and full-choke guns? Are these diameters of spread the same for all bores of guns?*

Answer.—The diameters of the spread of the whole shot charge at 40 yards are approximately 50 inches with an improved cylinder, 45 inches with a half choke, and 40 inches with a full choke. These diameters are approximately the same for all bores of guns since all sizes of guns are bored to give some definite pattern in the same sized circle (30 inches) at the same range (40 yards). In actual practice, however, variations are bound to occur and naturally the spread from an 8-bore is somewhat larger than that from a 20-bore. But the difference is not so great as might be imagined, as the larger the bore the denser the pattern, provided the same size of shot is used, because the bigger guns take heavier shot charges and so fire more pellets.

No. 56. Spread of the Shot Charge

Question.—*At what ranges does the standard load from a 12-bore $2\frac{1}{2}$-inch cartridge give a total spread of 30 inches in diameter when fired from improved-cylinder and full-choke barrels?*

Answer.—Twenty-five yards in the case of the improved cylinder and 30 yards in the case of the full choke.

No. 57. Length of Shot Column at 40 yards

Question.—*What is the length at 40 yards of the column of shot of a standard load of No. 6 when fired from an ordinary gun?*

Answer.—Not counting a very few straggling pellets, the length of the column is about 8 feet at 40 yards. The whole question of the Stringing of Shot was dealt with exhaustively in the *Field* of March 18, 1926, and all the results then obtained have lately been confirmed in America by Mr. P. Quayle, who has taken spark photographs of shot columns at different ranges.

No. 58. Effect of Swing on the Flight of the Shot Charge

Question.—*Many shooters believe that the " swing " one gives to one's gun affects the flight of the shot charge and imparts a corresponding " swing " to the shot, like water out of a hose Is there any truth in this theory?*

Answer.—No. When water comes out of a hose, or when a string of shots is fired from a machine gun, the water and bullets continue to leave the nozzle of the hose and the muzzle of the gun while that nozzle and muzzle are constantly changing the direction in which they are pointing. Consequently the water and bullets are distributed over a wider area than would be the case if the hose or machine gun were stationary. But in the case of a shotgun the column of shot is just about 1 inch in length when it leaves the muzzle The time which elapses between the departures of the head and tail of the shot column from the muzzle is less than one ten-thousandth part of a second, the average time being about 0·00007 of a second In this small period of time the barrels of the gun would not have changed their direction to any appreciable degree, no matter how vigorously the shooter made his swing, and consequently the " water from a hose " effect could not possibly be produced.

Nor is there any truth in the theory that swing throws the shot forward to any practical extent. It is true that the actual velocity of the shot charge is the resultant of two velocities which act at right angles to one another, namely, the velocity due to the combustion of the powder which is imparted in the direction of the bore, and the velocity imparted by the swing which acts in a direction at right angles to the bore of the gun. The former velocity, however, is so much the greater that the latter has no practical effect whatever.

No. 59. Pressure and Velocity

Question.—*In the "Field" reports of cartridge tests the following statement sometimes occurs: "The velocities were perfectly satisfactory, but the pressures were somewhat on the low side. These cartridges would probably prove quite effective, but we would prefer to see higher pressures." If the velocity is satisfactory, is not the penetration satisfactory? And if so, what more can be gained by a higher pressure?*

Answer.—If the velocity of a shot charge, when fired out of a sporting gun, is satisfactory, the penetration will be satisfactory, as the penetration depends on the velocity. The velocity, however, is generated by the pressure, and the pressure is affected by the size of the bore and chamber in which the cartridge is fired. Ballistic tests are always carried out with pressure barrels which are bored to the minimum dimensions permissible, and consequently the cartridge fits very tight in the chamber and the wads fit tight in the barrel, thus helping to compress the powder gases and develop the maximum pressure possible. Sporting guns are never bored to quite such close dimensions so as to avoid risk of jams, and consequently the pressure developed in such guns is never quite so high as it would be in a pressure barrel. Many guns in common use are old, worn and loose in the bore and chamber, and such guns bring about a considerable reduction in pressure.

If, therefore, the pressure is only just sufficient to produce a satisfactory velocity in a tight pressure barrel, no allowance is left for the reductions which are inevitable when the cartridges are used in old and worn guns, and under such conditions there is every chance of the pressure being so reduced that the velocity generated is no longer satisfactory. Consequently a warning is necessary when making a report on the tests, and in certain cases where the conditions are such as to tend to the production of

low pressures (*i.e* , when cork or feltine wads are used, or abnormally light powder or shot charges), a suggestion is made to the effect that a slight increase in the powder charge might be an advantage.

No. 60. The Effect of Air Resistance on Different Muzzle Velocities

Question.—*In the answer to Question No. 9 it was stated that when charges of shot are propelled with different velocities this difference becomes negligible at sporting ranges although it may be considerable at the muzzle. Why is this?*

Answer.—When a charge of shot travels through the air it loses velocity all the time during flight on account of the resistance which the air offers. The greater the air resistance the more rapidly is velocity lost. Further, an increase in the velocity of the shot charge results in a very much greater increase in the air resistance, this resistance varying roughly as the square of the velocity. That is to say, if the velocity of the shot charge is doubled, the air resistance becomes four times as much. Consequently a shot charge which is propelled with a high muzzle velocity loses speed much more rapidly than does a similar shot charge which is propelled with a low muzzle velocity, on account of the greatly increased air resistance. This means that the actual difference between the striking velocities of the two similar shot charges gets less and less as the range increases. For example, a difference in velocities in the neighbourhood of 100 feet per second at the muzzle has been reduced to one of between 40 and 50 f.s. at 10 yards and to one of about 10 f.s. at 40 yards.

No. 61. Effect of Reduction of Shot Charge on Velocity

Question.—*I have frequently seen it stated that a lighter shot charge than the standard, say, one ounce or even less, does not result in any higher velocity being generated. Is this so, and if so, why?*

Answer.—A shot charge of an ounce, being lighter, does not offer so much resistance to the powder gases as one of one ounce and a sixteenth Consequently it is propelled at a lower pressure and the velocity generated is frequently no more than that developed with the heavier charge If, however, the cartridge is tightly loaded and the turnover is firm, a normal pressure results, in which case the velocity is slightly higher. The degree of "tightness" with which a cartridge is loaded has more effect on the ballistics than is generally realised

No. 62. The Extreme Killing Range of an Ordinary 12-Bore

Question.—*What is the extreme range at which game can be killed with an ordinary 12-bore shotgun?*

Answer.—The individual pellets of a charge of No. 6 shot possess sufficient velocity up to a range of 70 yards to ensure penetration in the case of the pellet striking the head or neck of an ordinary game bird, but it is obvious that such a small target cannot be hit without great luck when the pattern is as open as it is at 70 yards. The truth is that any kill made at a range of over 50 yards is in the nature of a fluke because the pattern is too open, even when a full choke is used, to give a reasonable chance of a pellet striking a vital spot.

No. 63. Extreme Range of 12-Bore Shotguns

Question.—*What is the extreme range of an ordinary* 12-*bore shotgun with No* 6 *shot when the gun is fired* (*a*) *horizontally and* (*b*) *at an angle of* 45 *degrees? Also what is the height attained by the shot when the gun is fired vertically?*

Answer.—In the first place it must be realised that at extreme ranges the shot charge has spread out to a very appreciable degree along the direction of flight and consequently the central portion of the charge only can be considered In round figures the ranges for No 6 shot are as follows: When the gun is fired horizontally, 100 yards. When the gun is fired at an elevation of 33 degrees (which gives the maximum range), 220 yards When the gun is fired vertically the shot will attain a height of 120 yards.

No. 64. Remaining Velocity of a Projectile Fired Vertically

Question.—*If a projectile were fired absolutely vertically would it not, in theory, return to the point of departure with the same velocity as that with which it started? In practice this is obviously impossible. Why?*

Answer.—*In vacuo,* where there is no air resistance, a projectile fired vertically would return to the point of departure with exactly the same vertical velocity as that of projection. This theoretical condition, however, cannot exist in actual practice on account of the resistance of the air. The resistance offered by the air prevents the projectile going so high as it would in a vacuum; consequently, for this reason alone, the projectile would not attain the same speed when it returned to the point of departure as it would have in a vacuum, because it would not have so far to fall. Further, during its return to the point of departure the velocity which it acquires through gravity is reduced by the air resistance, and consequently this makes a second reason why the velocity of the projectile when returning is less than that with which it started.

No. 65. Storing a Gun

Question.—*What is the best method of storing a gun which is not going to be used for several months?*

Answer.—The gun should first of all be thoroughly cleaned, and it is a good plan to clean out, the barrels with boiling water. After this has been dried out the barrels should be smeared inside and out with a fairly thick oil or jelly. Vaseline will answer the purpose well, but a better composition can be made by mixing vaseline and B S A Kleenwell oil in equal parts. The vaseline should be melted, the oil added and well stirred, and the mixture then allowed to cool. The action can be treated in the same way, and the gun put away in its case, or else in a gun cabinet or cupboard.

No. 66. Compression of Action Springs

Question.—*Which is the best way of putting aside an ejector gun between shoots so as to release the ejector and main springs from constant strain due to compression?*

Answer.—It is no more necessary to release the main, or tumbler, springs or the ejector springs of a gun than it is to release the springs of a watch. The loss in strength owing to compression is negligible, even after many years.

The main springs can be released by pulling the triggers. If the gun is in pieces it is better to hold the face of the action against a block of wood, or an old book, when snapping off, so as to give the strikers something fairly hard against which to fall. If the gun is assembled, snap caps should be employed.

The ejector springs present a more difficult problem. In the great majority of actions the simplest way of keeping them released is to remove the fore-end while the gun is still in the " open " position immediately after the snap caps have been ejected. The barrels can then be taken from the stock in the ordinary way. If this is done, however, the ejector hammers must be recocked before the gun can be put together again To do this the fore-end should be attached to the barrels alone, when it will be found that the ejector heads are protruding beyond the breech end of the barrels owing to the fact that they are held in their extreme backward position by the ejector hammers, which are now uncocked. The barrels should now be gripped firmly and the ejector heads pressed down on some wooden surface, such as a table, until a click is heard which denotes the cocking of the ejector hammers The ejector heads will then lie flush with the breech of the barrels, and if the fore-end is removed, the gun can be put together in the usual way.

No. 67. Detection of Loose Actions

Question.—*In the answer to Question No. 20 it was stated that an abnormally severe strain on firing might cause the barrels of a gun to come off the face of the action What exactly does this mean, and how can such a state of affairs be detected?*

Answer.—A pair of barrels are said to have been lifted "off the face of the action" if the breech end of the barrels no longer fits tightly against the face of the action; that is, against the flat vertical part of the action (when the gun is held in a horizontal position).

If the barrels have been lifted badly off the face of the action daylight can be seen between the breech end of the barrels and the action when the gun is closed and held up against the light. The simplest way of testing whether the action is quite tight or not is to hold the closed gun with the barrels uppermost in a horizontal position firmly with the left hand, grasping the barrels and stock in front of the trigger guard, and then to hit the heel of the stock sharply with the fist of the right hand. If the action is at all loose a distinct rattle will be felt in the left hand every time the gun is struck

No. 68. Dents in Shotgun Barrels

Question.—*On sending my gun to the makers recently they informed me that there were two dents in the right barrel and one in the left which should be taken out I was quite unable to see any of these dents. Is there any special method for detecting dents?*

Answer.—Perhaps the easiest way of detecting a dent is to examine the outside of the barrel rather than the inside as is usually done. The barrels should be removed from the stock and held out just below and in prolongation with the eye, and then manipulated until some dark mass —the top edge of a window is excellent for the purpose— casts a shadow-like reflection on the barrels It will be found that this reflection takes the form of a thin dark line running longitudinally along the uppermost part of the surface of the top barrel. If this line is foreshortened any dent which may happen to lie on it will immediately show as a break. If there is no such break there is no dent on the longitudinal line. The barrels should then be revolved in turn until the dark line has been thrown on every portion of both barrels, when any dent which may exist will be noticed.

No. 69. Dents in Gun Barrels

Question.—*There is a dent on the underside of the right (improved cylinder) barrel of my 12-bore shotgun. It is about six inches from the muzzle and a ridge shows when looking down from the breech. It was accidentally caused by the gun falling on the edge of a stone wall or something similar and is quite sharp, while the ridge on the inner surface of the barrel is very slight Will this affect the shooting of the gun, which is a high-grade one specially built to my order?*

Answer.—Even a slight dent usually affects a gun's shooting by causing irregularity in the pattern, and on this account, if for no other reason, the gun should be returned to the maker without delay to have the dent removed.

If the gun is used much after a dent is made the walls of the barrel will be weakened at the site of the dent because the passage of every charge of shot and wads up the bore and over the dent (which is a raised lump on the inner surface of the bore) must mean wearing away of the metal raised by the dent. In the case of a very bad dent this wearing action due to shooting would ultimately result in a hole, while with even slight dents the metal must be weakened.

As soon as a dent is noticed the gun should be sent to some competent gunsmith (preferably the maker) who can remove the dent by raising the metal from the inside of the bore The more a gun is used after a dent has been made the more difficult it is for a gunsmith to raise the dent without leaving any trace.

No. 70. Preservation of Colour of Lock Plates

Question.—*I have recently purchased a new best-grade gun. The lock plates are an exceptionally nice blue, and I would like to preserve this colour if possible. Is there any means of doing this?*

Answer.—Any part of the action which has been case hardened, including the lock plates, will lose its colour gradually with use. The colour can, however, be preserved for many years provided the surfaces are protected by varnish. The lock plates of best guns are usually covered with a special varnish when the guns are finished, but this varnish wears off after a season or two of use The best plan is to send the gun back to the maker at the end of every shooting season in order to have the lock plates and action revarnished If this is done the original colour will last for many years.

In any case it is advisable to send guns back to the makers at the end of each shooting season for a thorough cleaning and overhaul, as it is always possible that rusting has set in somewhere in the action owing to some severe soaking on a wet day. If taken in time no harm will result.

No. 71. Blueing of Barrels and Actions

Question.—*I have a ·410 gun and would like to blue the barrel and action. How is this done?*

Answer.—The blueing of gun barrels, or any part of the actions, is not an easy process, and it is unlikely that an amateur would be able to obtain good results, while there is a good chance of his spoiling the weapon Consequently it is always better to place the weapon in the hands of some competent gunsmith.

Briefly, the procedure is as follows: First clean the parts to be blued very thoroughly and then dip them in the blueing solution, or else wipe them over with the solution. There are a number of different solutions used, but perhaps a mixture of two parts water to one part of ordinary commercial nitric acid is as simple as any Then wash the solution off and clean the surface well with a wire brush This procedure should be repeated several times in order to obtain a really good colour When the part to be blued has received its final coating or dip and the solution has been entirely removed, it should be heated up to a dull blue heat and then dipped in some oil, such as castor-oil.

When blueing barrels the breech and muzzle ends should be corked so as to prevent any of the solution getting inside the bore.

No. 73. Wire Brushes for Cleaning Shotguns

Question.—*Is the use of a wire brush for cleaning the barrels of a shotgun harmful in any way?*

Answer.—There is always a risk of slight scratching of the surface of the bore if a wire brush is used, but if the brush is made of brass or soft iron wire this risk is not serious Theoretically, brass is not a very suitable substance for a brush for cleaning firearms because, during use, small particles of the brass will almost inevitably adhere to the bore: this close contact of brass and steel is likely to set up electrolytic action which is conducive to formation of rust. At the same time it must be admitted that brass brushes are constantly used without ill effects

There can, however, be no doubt that the safest and best method for removing leading, or any other obstinate fouling, is by the use of some mild abrasive paste (B S A. "Cunirid," for example) on a rag wrapped round the jag of the cleaning rod so that it fits the bore tightly.

No. 74. Leading in Shotgun Barrels

Question.—*Near the muzzles of a pair of 28-bore barrels there are a number of dull greyish longitudinal streaks inside the bore which resist all ordinary methods of cleaning They were not noticeable when the gun was new. What are these streaks and how can they be removed?*

Answer.—The streaks are undoubtedly leading. The constriction caused by a heavy choke, and small bore guns are almost always very heavily choked, imposes additional friction on the shot charge when it passes the choke and lead is scraped off the outside pellets and deposited on the inside of the bore. This is a common type of fouling in all fully choked guns and it is also found frequently on the cones at the heads of the chambers, where a similar constriction occurs. Leading can be removed easily by cleaning with some B.S A. "Cunirid" paste smeared on a rag Very severe cases can be treated with mercury. The muzzle of the barrel to be treated should be corked, then a small amount of mercury poured into the bore, when the breech end should be corked. The mercury is then shaken up and down the bore, when it combines with the lead fouling, and this combination can be emptied out when the bore is clean. Such treatment, however, should never be necessary when "Cunirid" paste is used.

No. 75. Cleaning Firearms with Water

Question.—*The Americans are strong advocates of cleaning out both guns and rifles with boiling water. Is this a good plan, and is it necessary?*

Answer.—The advantages of hot water as a cleaning agent for firearms have long been known and are not an American discovery; in fact, the use of hot water goes back to the days of muzzle-loaders. However, Dr. Wilbur Huff, an American, made fairly exhaustive researches in 1920 by which he showed that the primary cause of rusting in barrels was the residue of potassium chloride from the cap composition and that this residue was completely removed by washing a barrel out with water. This was no new discovery, but Dr. Huff deserves every credit for a very thorough investigation.

In the case of shotguns when modern British powders are used, such as Smokeless Diamond, E.C. or Schultze, the water treatment is not necessary because these powders leave a residue which counteracts, to a large extent, that left by the cap But when foreign powders are used the water treatment is a wise precaution.

In the case of rifles the water treatment should always be used without fail The water need not be boiling Cold water is almost as efficacious, but hot water evaporates and is thus more easily dried from the bore.

No. 76. Removal of Metallic Fouling from Rifles

Question.—*What is the best way of removing the metallic fouling from a rifle barrel which is badly " nickelled " ?*

Answer.—There are two general methods of removing metallic fouling, chemical and non-chemical In the chemical method one end of the barrel is corked and the bore is filled with a solution of ammonium persulphate for about 20 minutes. This solution has no effect on steel, but dissolves copper and nickel. Tablets known as K N S can be obtained from any gunmaker and when dissolved in a solution of ammonia provide the proper fluid to use for removing nickel chemically.

One disadvantage of this method, however, is that it makes the bore *too* clean, as it removes the nickel from any pits there may be. The result is that the bore becomes rough and soon nickels again After K N.S it is a good plan to fire three or four rounds and then to scrub the bore well with some mild abrasive. The pits in the bore will then be filled up and the inside of the barrel will be smooth.

The non-chemical method entails the use of some abrasive paste on a rag which rubs the nickel away. Such pastes can be made from pumice powder or even metal polish such as " Brasso," while special pastes are sold for the purpose, notably " Motti," B S.A. " Polishing Paste " and B.S.A. " Cunirid " This last is far the best and safest to use, as all the others mentioned (including pumice and " Brasso ") wear away the steel as well as the nickel to varying degrees. In the hands of an expert, however, " Motti " or " Polishing Paste " will remove the nickel far more quickly on account of their rapid abrasive action. But the amateur is advised to use " Cunirid " only.

No. 77. Cleaning of Rifles after Firing "Non-Fouling" Bullets

Question.—*One frequently hears emphasis laid on the fact that the bullets used in some particular rifle are jacketed with "Nobeloy" envelopes which prevent metallic fouling. When using such bullets, is it necessary to clean out with B.S A. "Cunirid," or some other abrasive paste, after firing?*

Answer.—It is not essential, but it is certainly better to use some abrasive paste. When "Nobeloy" bullets are used all that is necessary in the way of cleaning is to scrub the barrel out well with some "Cunirid" paste smeared on a bristle brush which will remove both powder and cap fouling as well as the almost negligible deposit of metallic fouling The bore can then be wiped out with an oily rag, so as to remove the dirty remains of the paste, and finally left coated with some suitable oil, as a preservative against rust.

No. 78. Necessity for Cleaning Rifles with Water

Question.—*In the reply to Question No. 77 it was stated that all that is necessary in the way of cleaning rifles which fire "Nobeloy" bullets is to scrub out the barrel with some "Cunirid" paste smeared on a bristle brush But in a previous reply to another question it was stated that it is always advisable to wash out the bore with water (either hot or cold) so as to remove the potassium chloride deposited by the cap. Surely the employment of "Nobeloy" bullets cannot affect the cap fouling, and if water is necessary for the removal of this fouling should it not be used when any type of bullet is fired?*

Answer.—In previous replies the use of water has been recommended because it is a certain method of removing the potassium chloride cap fouling, and also because comparatively few sportsmen take the trouble to use an abrasive cleaning paste. If an abrasive paste is used the water treatment is really a superfluous step, although it can never do harm. If no abrasive paste is used the water treatment should never be omitted.

No. 79. Meaning of "Jump" and "Flip"

Question.—*What exactly is meant by the term "flip" when applied to rifles? Is it the same as "jump"?*

Answer.—The Artilleryman defines jump as the difference between the angle of elevation and the angle of departure In other words, it is the vertical angle which the axis of the piece describes under the shock of firing during the interval between the ignition of the powder charge and the exit of the projectile from the muzzle When the muzzle of the piece moves upwards the jump is said to be positive, and when the muzzle moves downwards the jump is negative

In rifles and shotguns there are really two elements of jump which should be distinguished These are: (1) The weapon moves as a whole about the point of the stock where the recoil is taken and gives a positive jump; and (2) the barrel bends, or flips, during the same interval of time in which the first mentioned movement of positive jump is taking place. The second of these two elements is much the more important, as it exercises the controlling factor on the total movement of the weapon during the shock of firing, and consequently in sporting and military small-arm gunnery the term flip is invariably used in place of jump and is regarded to include both elements.

The flip of a barrel consists partly of a bending, just as a fishing-rod bends when the angler strikes, and partly of a vibrating set up in the barrel by the movement of the cartridge case and breech fittings under the sudden application of the powder pressure. The bending of the barrel during recoil is always negative, because the barrel becomes the arc of a circle and the axis near the muzzle has a direction downwards in regard to its original position, just as the point of a fishing-rod assumes a more downward direction when the angler strikes But the effect of barrel vibration may be either positive or negative according to

the time the bullet takes to travel up the bore, and whether the bullet leaves the muzzle at the top or bottom of a vibration. Actually the resultant flip is the sum of these two effects.

Flip varies with every barrel and action, and even with the same barrel and action when they are bedded differently to the stock. It is dependent on the length and thickness of the barrel; the method of support which the barrel receives; the rigidity of the attachment of the barrel to the action, as well as the action itself; and the tightness of the bearing between the action and the stock.

In actual practice the effect of flip is counteracted in the sighting of the weapon.

No. 80. Measurement of Flip

Question.—*Is there any means of measuring the flip of a rifle?*

Answer.—Flip can easily be measured by arranging the sights so that the line of sight is absolutely parallel to the axis of the bore. The rifle should then be shot at 25 yards, when, if there were no flip, the bullets would strike the target the same distance below the point of aim as the axis of the bore is below the line of sight. The difference between this theoretical point of impact on the target and the actual impact gives the flip. If, for example, the axis of the bore is 1½ inches below the line of sight, the bullets would strike 1½ inches below the point of aim if there were no flip It is found, however, that they strike 5½ inches below the point of aim; and so the effect of the flip is to throw the bullets 4 inches low at 25 yards. Since 1 inch at this range subtends an angle of ¼ minute, the total flip is 16 minutes, and as the effect is to throw the bullets downwards, the flip is negative.

No. 81. Alteration in a Rifle's Elevation

Question.—*I have a ·375 Mannlicher-Schonauer rifle, which until recently shot remarkably accurately. Recently, when on a trip up the Zambesi, something went wrong with the trigger pull and on my return I sent the rifle for repair to a gunmaker, who put the trigger pull quite all right again. But after I got the rifle back I missed three easy shots at buck, and in each case my bullet went over the animal's back, so I tested the rifle on a target and made a 4-inch group at* 100 *yards, but* 10 *inches directly above the bull. The ammunition was the same as I had used before and was quite fresh. The sights have not been damaged in any way. The backsight cannot have been raised as it slips in sideways, while it is impossible for the foresight to have been lowered. How is it possible to explain the sudden change in elevation?*

Answer.—When the gunmaker had the rifle for correcting the trigger pull he must have stripped the barrel and action from the stock. When reassembling the rifle it is probable that some slight change in bedding took place, or else the action screws were screwed up with a different degree of tightness. This change in the bedding of the barrel and action to the stock would be quite enough to cause a change in the flip of the rifle which, in its turn, would result in a change of elevation. If you are satisfied that the action screws are perfectly tight, your best remedy is to file down the backsight a little so as to correct the elevation to the present condition of the rifle.

No. 82. Resting a Rifle on a Hard Support

Question.—*Why is one always warned that it is a bad plan to rest the barrel of a rifle on some hard support when shooting?*

Answer.—A hard support such as a bar of iron, a rock, or the branch of a tree, possesses no elasticity, and consequently if the barrel of a rifle rests on some such support when it is fired, the support interferes with the natural flip of the rifle, with the result that the sighting is altered. There is a tendency for the barrel's downward flip to be prevented before the bullet has left the muzzle, and therefore a high shot is almost inevitable for the sighting taken.

It is always better to place some soft material such as a cap, scarf, handkerchief, or glove between the support and the barrel; or else to rest the hand on the support.

No. 83. "Mean Point of Impact"

Question.—*What exactly is the meaning of the expression "Mean Point of Impact"?*

Answer.—The Mean Point of Impact, or M.P.I., is really an artillery expression, and denotes the centre of a group of consecutive shots made at any range when the same aim is taken in each case.

No. 84. The Effect of Wind on a Bullet's Flight

Question.—*To what extent is a bullet in flight affected by the wind? For instance, if the wind was blowing at 15 f.s. from the target to the shooter, would the velocity of the bullet be reduced all along the range to the extent of 15 f.s.? Or, again, with a wind blowing at 15 f s. at right angles to the line of fire, would the bullet be deflected 15 feet for every second of its flight?*

Answer.—Probably the easiest way of appreciating the effect of a head wind on a bullet's flight is as follows:

The velocity of a bullet is measured with reference to the rifle, or the ground on which the rifle is situated. When a bullet has a velocity of 2,000 f s in still air, the air passes over the bullet at a rate of 2,000 f s. Now, when the air has some general movement of its own, this movement can only alter the 2,000 f.s with which the air is passing over the bullet. If, for example, a wind blows at 15 f s against the bullet's movement, then the air will be passing over the bullet at 2,015 f.s.

It is clear that this additional 15 f.s cannot rob the bullet of 15 f s. of velocity because if it did so the bullet would come to rest in still air after having travelled only 2,000 feet, which it does not.

The effect of the wind is a proportional one, and in the example given would help to resist the bullet's movement. But this resistance alters constantly with the bullet's velocity, as this is reduced in the bullet's movement up the range

In actual practice a bullet would lose about two-thirds of the wind's velocity after a flight of 1,000 yards on account of the effect of wind blowing from the target to the rifle. That is, a 15 f s. head wind would result in additional loss of 10 f s. velocity after 1,000 yards.

In the case of a wind blowing at right angles to the line

of fire the bullet would be blown about one-third of the wind's velocity out of its path. That is, a 15 f.s. wind would result in the bullet being deflected about 5 feet for every second of its flight.

The figures given here have been calculated from the example of the ·303 Mark VI bullet given in the *Text Book of Small Arms*, 1909, but they can be taken as being approximately correct for most bullets ordinarily used, although they must naturally vary with different bullets and the velocities at which they are projected.

No. 85. The Comparative "Quickness" of Bolt Actions and Hammer or Hammerless Actions

Question.—*Which is the quicker type of rifle action, a bolt action or a hammerless, such as is used with double rifles? Or, in other words, what is the difference in the time which elapses between the pressing of the trigger and the striking of the cap when a bolt action rifle or a double hammerless rifle is used?*

Answer.—There is no difference in the time which elapses between the pressure of the trigger and the striking of the cap when a hammer or hammerless action is used; but both these types of actions are considerably quicker than any bolt action.

Consequently a perfect trigger release and firm holding is even more essential to good shooting in the case of a bolt action rifle than in a double hammerless rifle.

Bolt actions, however, usually give a decidedly stronger blow than a hammer or hammerless action, but if the blow is strong enough to explode the cap properly no further strength is necessary.

No. 86. The "Regulating" of Double-Barrelled Rifles

Question.—*Is it a fact, or is it not, that the barrels of a double-barrelled rifle are fixed absolutely parallel to one another?*

Answer.—The axes of the barrels of a double-barrelled rifle are never quite parallel, although in some rifles they may be nearly so. The amount of divergence from a true parallel position depends on the cartridge which the rifle fires and the individuality of the weapon, and consequently the exact relative position of the barrels of two double-barrelled rifles are hardly ever the same. This position of the barrels can only be determined by a number of tests at a target in what is often a prolonged series of trial and error experiments, and it is this fact which accounts for the exceptional skill required in the building of a double rifle as well as for the high price which must necessarily be charged.

The reason for the necessity of such tests is as follows:

The axes of the two barrels of a double rifle in which the barrels are side by side must clearly lie on either side of the centre of gravity of the weapon. When the right barrel is fired there is consequently a tendency for the muzzle to be swung outwards to the right, and when the left barrel is fired the muzzle is thrown out to the left. If the axes of the bores were truly parallel the obvious result would be that shots from the right barrel would be thrown to the right of the point of aim, while shots from the left barrel would be thrown to the left.

In order to overcome this "shooting apart" of the two barrels the axes of the bores are set slightly converging at the muzzle. The amount of this convergence depends largely on the velocity developed by the cartridge. In the simplest language it can be stated that the faster a bullet travels up the barrel the sooner it leaves the muzzle, and

consequently the rifle will not have had time to swing outwards so far as it would have had in the case of a bullet which moves up the bore more slowly. The result is that rifles with high muzzle velocities do not need the same amount of convergence in the axes of their barrels as do rifles with low muzzle velocities, and the axes of the barrels of rifles which take cartridges developing muzzle velocities of round about 3,000 f s. are almost parallel, while the axes of the barrels of ball and shot guns, which develop the lowest velocities, show the greatest degree of convergence.

But the actual amount by which the two barrels "shoot apart" is governed by other factors besides the velocity imparted to the bullet. These factors include the tightness of the junction of the barrels to the action; the elasticity of the action itself; and the individual whippiness of every barrel. Consequently the degree of convergence at the muzzle necessary for good shooting must vary with every weapon and cannot follow any rule, so that the only method of determining it is by actual shooting and "regulating."

No. 88. Sighting of Rifles at High Altitudes

Question.—*I find that my rifle, a sporting ·375 Mannlicher-Schonauer, shoots from 2 feet to 3 feet higher at 150 yards out in Kenya than it did in England. I attribute this difference in elevation to the rarefied air due to the altitude (5,000 to 9,000 feet). Is this correct? In any case, one effect of the rarefied air must be a greatly increased muzzle velocity.*

Answer.—Although a change of elevation of from 2 feet to 3 feet at 150 yards seems rather excessive, it is certainly a fact that most sportsmen have noticed that their rifles do shoot considerably higher on the Highlands of East Africa than they do in England with the same sighting and cartridges. But at sporting ranges up to 300 yards this difference in elevation has little or nothing to do with the rarefied atmosphere due to the altitude. Up to 200 yards no modern rifle would shoot more than from 2 inches to 6 inches higher when fired at 6,000 feet than it does at sea-level; and even at 300 yards the difference would in no case be more than 6 inches. The effect of the rarefied air would become more pronounced at and beyond 500 yards; and at this last-named range the difference might be about 2 feet.

This very general experience of sportsmen in East Africa is almost certainly a result of light. All target shots know how great the effects of variations in light can be, and there is undoubtedly something about the light in East Africa which makes men shoot high.

In the case of rifles firing cordite an additional reason for very high shots is often to be found in the increased ballistics due to the cordite being raised in temperature by the tropical sun. In very hot climates a rifle firing a charge of 75 grains of cordite will shoot a foot high at 100 yards, and so-called "Tropical Charges" are of little help.

The remedy is to use a nitro-cellulose powder instead of cordite.

The actual muzzle velocity is, for all practical purposes, unaffected by the reduction in atmospheric pressure due to altitude.

No. 89. The "Lead" in the Barrel

Question.—*What exactly is the "lead" in a rifle barrel?*

Answer.—The "lead" in a rifle barrel is the short, smooth and tapered portion of the bore which connects the head of the chamber to the rifled portion of the bore Although the correct spelling is "lead" it would greatly simplify matters if the phonetic spelling "leed" were universally adopted.

No. 90. Stream-line Bullets

Question.—*What exactly is a Stream-line Bullet, and what special advantages does it possess?*

Answer.—A Stream-line Bullet is a bullet which has a tapered base as well as a tapered head. The longitudinal section of such a bullet is very similar to a horizontal section of ship. The advantages of a stream-line bullet over an ordinary square-based one lie in its greater capacity for overcoming air resistance which gives it a much flatter trajectory at long ranges; a higher striking velocity at long range; and greatly increased ranging power.

No. 91. Stream-line Bullets

Question.—*Why is it that the tapered base of a stream-line bullet gives it greater capacity for overcoming air resistance?*

Answer.—When a bullet travels through the air there are two distinct kinds of resistance to its motion, namely, a resistance at the head which tries to push it backwards, and a suction at the tail which tries to pull it backwards. This suction at the base of the bullet is proportional to the diameter of the very end of the tail, and so a small tail means reduced suction. It is not possible in actual practice to utilise this fact to extremes and make the tail a sharp point, as such a bullet will not shoot accurately. The whole art in designing a stream-line bullet consists of making one which will shoot accurately but which has as sharp a tail as possible, so as to reduce the backward pull during flight and thus eliminate as far as possible one of the resistances to the bullet's forward movement.

No. 92. Stream-line Bullets

Question.—*If the addition of a stream-lined base gives to a bullet enhanced powers of overcoming air resistance which result in a flatter trajectory and greater striking velocity at any given range, why are stream-line bullets not used in sporting rifles?*

Answer.—There are two distinct kinds of resistance to a bullet's motion when travelling through the air, as was stated in answer to Question No. 91, namely, a resistance at the head and a suction at the tail. The former increases very rapidly as the velocity is increased, but once the space of low pressure at the tail (which causes the suction) has become a vacuum, this suction cannot increase any further, because a vacuum is the limit of low density which it is possible to attain.

In actual sport ranges greater than 300 yards need not be considered, and at these very short distances the velocity of a modern bullet is so high that the resistance at the head of the bullet is terrific, while the suction at the tail cannot increase beyond a certain point So it will be clear that at short ranges the suction at the tail is a very small proportion of the total resistance, and so its reduction by means of a stream-line base will have little effect on this total resistance.

Extreme accuracy, however, is essential And since it is easier to make a square-based bullet shoot more accurately than a stream-lined one, the very slight advantage which the latter type of bullet would give at short ranges is more than counterbalanced by the certainty of greater regularity in shooting of the former.

At long ranges, however, when the velocity has fallen considerably, the resistance at the head has also fallen, while the suction at the tail remains the same. In these

circumstances the suction at the tail constitutes a large proportion of the total resistances to movement, and so its reduction by means of a stream-lined base reduces the total resistance very considerably, with the result that the bullet retains its velocity better and so has a flatter trajectory and a greater striking velocity. In sport these conditions do not prevail owing to the short ranges at which shots are taken.

No. 93. Ballistics and Accuracy of Different Lengths of Rifle Barrels

Question.—*What would be the loss in velocity, energy and accuracy resulting from the reduction in the length of a barrel of a sporting rifle from 28 inches to 23 inches? One would imagine that accuracy would suffer considerably owing to the reduced sight-base and the shorter distance which the bullet would have to travel in the bore.*

Answer.—On the assumption that the rifle in question is a high velocity sporting weapon, the loss in muzzle velocity would be 3·4 per cent and in muzzle energy 11·6 per cent. The loss in accuracy would, for all practical purposes of sport, be due only to the reduction in sight-base, which depends on the type of rifle and the type of sights used. In the case of a double-barrelled or single-barrelled falling block weapon which is fitted with a V backsight, the sight-base would be about 20 inches with a 28-inch barrel and 15 inches with a 23-inch barrel, in which case any error in aim would be increased by 25 per cent. when the shorter barrel was used. With a bolt-actioned rifle the sight-base is longer, as the increased length of the action permits of the backsight being placed nearer the breech end of the barrel without being too close to the eye, and the respective sight-bases would be about 24 inches and 19 inches, in which case the shorter barrel would increase any error in aim by slightly less than 23 per cent.

With aperture sights the sight-bases would be longer in every case and the shorter barrels would only bring about a reduction of about 15 per cent. with a double or falling block action rifle and about 14 per cent. with a bolt action magazine weapon.

If a telescope sight were used there would be no loss in accuracy at all.

No. 94. The First Shot from a Clean Rifle Barrel

Question.—*In the reply to Question No. 27 it was stated that a shot fired from an oily rifle barrel is frequently not found in the middle of the group made when the barrel is slightly fouled. Does this also apply to a shot fired from a clean barrel which has been wiped free of oil? If so, how can one make certain of getting an absolutely true shot for the first shot of the day at a stag unless one fires a "blow off" round through the rifle before starting out for a day's stalking?*

Answer.—A rifle barrel can be in three conditions: oily; clean and dry; or slightly fouled by a previous round or rounds. A shot fired from an oily barrel cannot be relied upon, but one fired from a clean and dry barrel, which is free from oil, should be in the middle of the group made when the barrel has been fouled slightly by firing. Consequently, the first shot of the day should be absolutely true provided the barrel has been wiped free of oil. The best method of removing oil from a barrel and chamber is to wipe out with a rag dipped in petrol, which dissolves the oil. A run through with a dry rag will then ensure the barrel being perfectly dry.

No. 95. Advantages of Nitro-Cellulose Powder over Cordite

Question.—*What exactly are the advantages of a nitro-cellulose powder over cordite when used in sporting rifle cartridges?*

Answer.—Nitro-cellulose powders have two great advantages over cordite, namely: (1) they are much less severe in wear on the barrel as they do not generate such high temperature gases as are produced by the explosion of cordite, and (2) they are not nearly so sensitive to changes of temperature In a hot climate cordite develops considerably higher ballistics than it does in England, and consequently the sighting and grouping powers of a rifle are frequently altered when it is used in the tropics. A nitro-cellulose powder, on the other hand, is not affected to nearly the same extent by extremes of temperature, and consequently the sighting and grouping powers of a rifle are similar to the results obtained in England even when the rifle is used in some very hot country.

No. 96. Disadvantages of Nitro-Cellulose Powders

Question.—*In view of the most important advantages which nitro-cellulose powders possess over cordite for sporting rifles, why are they not universally used?*

Answer.—Nitro-cellulose powders possess disadvantages as well as advantages. For example, they are not so powerful as cordite, bulk for bulk, and in many rifle cartridges—especially those which were designed before the War—it is impossible to obtain the standard velocities with any nitro-cellulose powder because the cases are too small to permit sufficient powder being loaded to give the bullet the velocity required.

But even when the cases are big enough to allow the standard ballistics to be developed the cartridges will not keep in good condition for very long, especially when stored in a damp tropical climate, unless the caps are of a special type

Consequently if cartridges loaded with a nitro-cellulose powder are used, it is essential that they should be quite fresh. In the tropics, especially in countries where damp heat is prevalent at some time of the year, no nitro-cellulose cartridges should be used which are known to be more than twelve months old.

No. 97. "Lethal" and "Contractile" Bullets for Big Game

Question.—*Can "Lethal" or "Contractile" bullets be used from an ordinary shotgun with satisfactory results against big game?*

Answer.—Both Lethal and Contractile bullets can be fired from ordinary shotguns even when the guns are bored with heavy choke, but the accuracy is not so good in a choke barrel as in an improved cylinder, or cylinder, barrel Up to 50 yards, however, the accuracy should be sufficient for the normal requirements of practical sport.

Both these types of bullets give very effective results on game, but it should be remembered that the powder charges permissible in ordinary game guns cannot be sufficiently heavy to produce very great penetration and shock on large and heavy animals. Consequently these bullets should be used with caution, but for close-quarter work in thick jungle there can be no doubt that they enable a sportsman to use his ordinary game gun with excellent effect. But even so, the same killing power must not be expected as would be given by a heavy cordite rifle, such as a ·470.

No. 98. Safety of Straight-Pull Bolt Action

Question.—*Is the Ross Straight-Pull Action quite safe? I have heard of cases of the bolt blowing out on firing; also of the rifle opening of its own accord on firing. My own rifle has never done anything of the sort, and I like the action. But is it really safe?*

Answer.—When the bolt is properly assembled the Ross Straight-Pull Action is absolutely safe. The head of the bolt is held behind the chamber by an interrupted screw, not unlike the breech-block of a field-gun This screw is revolved by means of a stud which works in a spiral groove and which is actuated only when the bolt handle is drawn backwards. It is, however, possible to strip the bolt and to reassemble it incorrectly so that it can be inserted into the action and closed without the screw at the head revolving. When this is done the bolt is not held securely and it will then be blown out backwards if a cartridge is fired There are several authentic instances on record of such accidents; but the cause can only be incorrect assembling of the bolt. Incidentally, it is extremely difficult to insert an incorrectly assembled bolt into the action, and this can only be done by a combination of undue force and careful manipulation. If you do not make a habit of stripping your bolt you need have no fear as to the safety of your rifle

There is, however, another characteristic of this action which has given rise to ill-founded reports of its being dangerous. The thread of the interrupted screw at the head of the bolt happens to be cut at such a pitch that it can sometimes be revolved under the influence of a reduction of pressure when this reduction occurs at a certain rate The result is that the bolt will sometimes open after firing, but this opening is a comparatively gentle movement and is only caused by the falling off of the chamber pressure after firing There is no danger, because the screw cannot

revolve so long as the pressure is rising or is maintained, but only when it falls very rapidly towards vanishing-point. This opening is by no means universal with the Ross action and only occurs in certain individual rifles, and even then by no means always. The fact, however, that it does sometimes occur, combined with the reports of accidents which were the result of the insertion of an incorrectly assembled bolt, has given rise to the belief that the bolt is liable to blow out with violence and damage the shooter seriously. If your rifle has never opened after firing in the manner described it is unlikely to begin now and there is no reason for you to doubt its reliability.

No. 99. Ballistic Coefficient

Question.—*What is the "Ballistic Coefficient" of a bullet?*

Answer.—The Ballistic Coefficient of any projectile is a figure indicating the capacity possessed by that projectile for overcoming the resistance of the air and so retaining its original velocity. Other things being equal, a projectile with a good Ballistic Coefficient overcomes air resistance better than a projectile with a poor one, and consequently the striking velocity of the former is higher at long ranges than that of the latter, even though the muzzle velocities were the same. This capacity for retaining velocity also means a flatter trajectory, and consequently it will be realised that a good Ballistic Coefficient is a most important factor in any projectile.

The Ballistic Coefficient is invariably denoted by the letter "C" and depends on the weight of the projectile, its diameter, the shape of its head, and the tenuity or density of the atmosphere. In sporting gunnery this last factor is always assumed to be unity because it really does not have any practical effect in sporting ranges. The first three factors are, however, most important: the greater the weight, the smaller the diameter and the sharper the head, or nose, of the bullet, the better is its Ballistic Coefficient. In sporting gunnery the Ballistic Coefficient, or C, is always taken as being equal to $\frac{w}{n d^2}$, where w is the weight of the bullet in pounds, d the diameter of the bullet in inches, and n is an empirical value indicating the shape of the head.

The most difficult problem which the amateur ballistician has to face is the correct determination of n. Values of n for all British rifle bullets and a good many foreign ones will be found in the Appendix to *Notes on Sporting Rifles*, Second Edition, by Major Gerald Burrard, and published by Messrs. Edward Arnold, 4*s.* 6*d.* net.

No. 100. Coefficient of Steadiness and Ballistic Coefficient

Question.—*In the answer to Question No. 99 it was stated that a projectile's Ballistic Coefficient was dependent upon its weight, diameter, shape, and the density of the atmosphere. Is it not also partially dependent upon the steadiness of the projectile during flight, and is not this degree of steadiness indicated by the Coefficient of Steadiness?*

Answer.—In artillery work the Coefficient of Steadiness is taken into account and this is denoted by the Greek letter σ. In actual fact, however, little is known of the exact relation between a projectile's steadiness (or unsteadiness) during flight and its capacity for overcoming air resistance. In problems connected with sporting gunnery the Coefficient of Steadiness is either ignored entirely or invariably assumed to be equal to unity. The result is the same.